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Understanding Volcanoes in Isolated Locations: Engaging Diplomacy for Science

James Hammond

ONE in ten of the world's population lives within a hundred kilometers of a volcano that has the potential to erupt.[1] These people face immediate danger from future eruptions, but volcanic eruptions can have impacts far beyond their immediate surroundings. The 2010 eruption of the Eyjafjallajökull volcano in Iceland disrupted air traffic across Europe, causing an estimated economic impact of US$5 billion.[2] The biggest eruptions, such as that of Indonesia's Mount Tambora in 1815 (which ejected 150 to 200 times more rock than Eyjafjallajökull), have had global impacts on climate. The Mount Tambora eruption caused a 1 °C temperature drop and is linked to poor harvests and famine in parts of Europe and North America.[3] With increasing development and globalization, our vulnerability to volcanic hazards is increasing. Therefore, to minimize the impact of future eruptions, we must give attention to understanding volcanoes. With this in mind, the scientific study and monitoring of volcanic and other natural hazards provides a compelling opportunity for constructive science engagement through the shared goals of protecting life and property for global benefit.

In a recent study, volcanologists analyzed the risks associated with volcanoes in thirty-one countries around the world.[4] They concluded that volcanoes present significant risk to people living within a number of countries, but that just as

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concerning are the large uncertainties in many of these risk assessments. In other words, there are many volcanoes where the impacts of an eruption could be significant, but for which little or no information is currently available. The report suggests that volcanologists should prioritize these volcanoes for future study.

This lack of knowledge could be attributed to a number of causes: remote locations; a lack of local specialist training or adequate resources; or, in some cases, inhibited access to the volcano caused by political strains. Indeed, 193 volcanoes lie within countries under some form of international sanctions. These range from active volcanoes in the Democratic Republic of the Congo and Russia to those that have erupted within the last few thousand years (yesterday to a geologist) in places such as Syria, Sudan, and the Democratic People's Republic of Korea (DPRK, the formal name for North Korea). Just because these volcanoes remain difficult to access does not make understanding them any less important. Indeed, the humanitarian impacts of an eruption in these countries could be even higher because of strained relationships with the international community. It was with this in mind that Clive Oppenheimer and I accepted an invitation in 2011 from the DPRK to visit and discuss an increase in volcanic activity at Mount Paektu.[5]

Mount Paektu

Mount Paektu (also known as Changbaishan) is a dramatic yet enigmatic volcano on the border of the DPRK and China. Its summit, at more than 2,500 meters above sea level, is the highest point on the Korean Peninsula and holds significant cultural importance for all Koreans, being the purported birthplace of Dangun, the founder of Gojoseon, the first Korean kingdom. Mount Paektu has particular significance for DPRK people, presenting the base for the revolution led by Kim Il-sung. It is a regular pilgrimage site, with visitors either ascending the summit or visiting the restored revolutionary camps nearby, including the reputed birthplace of former leader Kim Jong-il. Indeed, the symbol of Mount Paektu permeates DPRK culture, featuring prominently in television broadcasts, in the DPRK national emblem and anthem, and as the backdrop for national leaders' statues at Pyongyang's Mansu Hill Grand Monument.

The volcano is equally fascinating to geologists worldwide. The spectacular four-kilometer-wide caldera lake at its summit, Lake Chon (also known as Tianchi), is thought to have formed in 946 AD during one of the largest eruptions in the last few thousand years—an eruption comparable to the 1815 event at Mount Tambora. More recently, a marked increase in earthquake activity and emission of volcanic gases has pointed to unrest at Mount Paektu.[6] Studies by both DPRK and Chinese scientists have suggested the recent developments were caused by an injection of molten rock from the earth's mantle (>35 kilometers) into shallow depths (~5 kilometers) directly beneath the volcano. While the volcano returned to its restful state in 2006, it focused domestic and international attention on the volcano.

Our 2011 trip marked the first time Western scientists had visited the DPRK's volcano observatories. We participated in a four-day workshop with approximately thirty DPRK scientists aimed at developing ideas for international collaboration on volcanology. The meeting culminated in two key questions that we all felt should be addressed: (1) What is the eruption history at Mount Paektu? (2) What is the current state of the volcano? On returning to the United Kingdom, and along with our colleagues at the American Association for the Advancement of Science (AAAS, publisher of *Science & Diplomacy)* in the United States, we developed a proposal focused on these two questions and presented these ideas to the Richard Lounsbery Foundation, which provided seed funding to allow us to put the project into action.

In a typical international scientific collaboration, the hardest steps are often developing a strong research idea, building a team, formulating a proposal, and obtaining funding. However, because of the significant political strain between the DPRK and the international community, we faced a number of unique challenges for this project that required us to develop and implement diplomatic skills to facilitate these important scientific objectives.

International sanctions against the DPRK posed our steepest challenge. During the planning stages of our project, volatility associated with the joint U.S.–South Korea military exercises, DPRK missile launches, and nuclear tests caused tensions to increase. The already strong international sanctions were increased resulting in significant delays to our work, and at times the delays and uncertainty threatened to derail the entire project.

The Eritrean Model

To overcome the diplomatic hurdles, we drew on our recent experiences on projects in Ethiopia and Eritrea, the latter being another country under international sanctions. Over the past twenty years, British and other international scientists have collaborated with Ethiopian scientists to study the East African Rift Valley, a large series of faults running from Mozambique in the south through to Ethiopia, Eritrea, and Djibouti into the Red Sea and the Gulf of Aden. This incredible natural phenomenon is the surface expression of large forces causing the African continent to slowly break apart, with a new tectonic boundary forming down the length of Africa.

The processes that occur at the northern tip of the rift are similar to those that happen at mid-ocean ridges. At these locations, as the tectonic plates are pulled apart, molten rock fills the gaps, generating new crust. However, mid-ocean ridges are below kilometers of water and are thus difficult and expensive to study. As a result, earth scientists are drawn to East Africa because it offers a unique opportunity to study these processes on land. Recently, through a large international collaboration, dozens of seismometers—sensitive instruments used to record earthquakes—were deployed in northern Ethiopia, right up to the border of Eritrea.[7] This work has allowed us to produce images from the surface to a few hundred kilometers deep, furthering our understanding of how a continent breaks apart.[8] However, the final stages of continental breakup on land are occurring in Eritrea, so it was important for us to collaborate with Eritrean scientists.

With this in mind, we opened communication with scientists at the Eritrea Institute of Technology in July 2009 and, as is typical when discussing science with like-minded experts, we received a warm response. We started to develop agreements to formalize our collaboration, but in December 2009 international sanctions linked with border disputes and instability in the Horn of Africa, led by the UK and the United States, were imposed on Eritrea. Because of British involvement in these sanctions, it became impossible for us to implement our plans and deploy instruments in Eritrea. However, we continued to discuss our research and plans with our Eritrean colleagues. Through this relationship and despite continuing political tensions, we were invited to present our proposal at a mining conference in Eritrea. This was an opportunity to present our scientific case and develop local support with both Eritrean scientists and government officials. Our proposal—to use seismology to provide detailed images of how Africa was tectonically breaking apart—focused on clear scientific objectives with no political agenda. It was enthusiastically backed. Two years after our initial contact, despite the ongoing political tensions, we received support from the Eritrean government to travel to Eritrea to deploy our seismometers, the first broadband seismometers ever deployed in the country.

Thanks to a strong relationship and mutual trust with our Eritrean peers, we were uniquely positioned in June 2011 to respond to the eruption of the country's Nabro volcano.[9] We deployed another eight seismometers and recruited an Eritrean PhD student in the effort. Despite the challenges funding overseas PhD students in the UK, this became a key measure of the project's success. Funding a regional PhD student allowed us to deliver on our promises to develop local skills, thereby enhancing our relationship with both Eritrean scientists and government officials. The PhD student is working on our data and developing skills in earthquake and volcanic hazards that will be valuable to Eritrea in the future.

From this process, we learned some valuable diplomacy for science lessons:

1. For science collaboration to succeed during periods of political strain, clear, strong scientific objectives that can be separated from any political agenda are essential.
2. It is important to have scientific collaborators who are passionate and driven about these science objectives.
3. For the collaboration to work, good communication is essential.
4. Setting realistic objectives can help participants deliver on promises (e.g., our funding of the Eritrean PhD student).

These factors are important in establishing trust between the partners, an essential part of any collaboration, but are even more important when political strain is present.

Applying Lessons in the DPRK

We used our experience in East Africa to develop a network of people to facilitate our collaboration with DPRK scientists. We had already achieved our first two objectives:

1. Strong scientific focus: Driven by the recent unrest at the volcano, both DPRK and international scientists recognized the need to understand more about the driving forces behind and geological history of the volcano.
2. Enthusiastic scientific partners: The research collaboration was initiated by our DPRK collaborators and, through their long history of research, it was clear that monitoring and understanding the volcano was a scientific priority in the DPRK.

The next step was to develop good communication. Despite our initial meeting, it was not possible for us to directly contact the geologists at the Earthquake Administration, DPRK while outside of the DPRK, but we took advantage of good communications between two environmental NGOs working in the DPRK (in fact, it was through this channel that our initial invitation was issued). An international NGO, the Environmental Education Media Project, with twenty years of experience working in the DPRK has for the last ten years been working with a DPRK NGO, the Pyongyang International Information Centre of New Technology and Economy (PIINTEC). Through PIINTEC's good relationships with the Earthquake Administration, we had an effective mechanism for communication. Despite this, face-to-face communication was essential to the effort, and one or two meetings were held annually between us, PIINTEC, and the Earthquake Administration. Typically these meetings took place in Beijing (2012) or Pyongyang (2013, 2014), with occasional opportunities to meet in Europe (Berlin 2013, Paris 2014). The need for translation added extra complications, but a common understanding and enthusiasm to address the big scientific questions, effective translators with scientific backgrounds, and patient discussion allowed us to overcome these challenges.

For this project, however, a second avenue of communication was necessary—that between us as scientists and international government organizations that provide export licenses to comply with international sanction regulations. Here, we received valuable advice and support from AAAS in the United States and the Royal Society in the UK. These organizations work at the intersection of science and policy, which allowed us to better communicate our clear, strong scientific objectives to the relevant government institutions.

Despite all this support, we still faced major challenges. Our project aims involved using sophisticated and sensitive equipment to record earthquakes and measure the earth's conductivity—proven methods of showing where molten rock may be stored beneath a volcano. This led to a two-year discussion with UK and U.S. authorities that ultimately failed to yield the appropriate licenses to use equipment to measure the earth's conductivity. The technology we sought, which can measure the magnetic-field fluctuations caused by storms and solar activity, has similar capabilities to equipment used in submarine detection. This means it is classified as a dual-use item—an item that could be used for civilian as well as military purposes. We had to revise our plans accordingly, requiring a longer deployment of seismometers to achieve our main scientific objectives. Again, clear and open communication was key in discussing this with our DPRK scientific colleagues.

All these challenges, whether in communication or exporting equipment, highlight a fifth lesson in using diplomacy for science—flexibility.

With this network of institutions in place and our licenses issued by UK and U.S. governments, we were able to travel to the DPRK in August 2013, with our broadband seismometers, and our team of UK and U.S. geologists could begin recording earthquakes and collecting geological samples.[10] The mutually trusting relationship established among our international group of scientists has facilitated a number of successes. Through amazing access to geological outcrops never before granted to international scientists, together with state-of-the-art homes for our seismometers built by DPRK scientists and corresponding excellent data quality, we have submitted our first joint publications to leading international journals, these will be the first joint Western-DPRK publications ever in the field of earth science.

Much of the work was conducted during a month-long visit to the UK by three DPRK scientists from the Earthquake Administration and State Academy of Science, together with a translator from PIINTEC. This culminated in a meeting at the Royal Society where DPRK scientists presented results to the UK volcanology community—the first ever engagement between the Royal Society and the DPRK. Since this meeting, we have presented our results together with our DPRK colleagues at meetings in China, attended by Chinese and South Korean scientists. We are now planning future, more ambitious projects, hopefully including training opportunities and infrastructure development to allow us to better understand Mount Paektu, facilitate future monitoring, and extend our collaboration to other areas of earth and environmental science.

The success of this project and our ability to plan for the future was only possible by observing these five guidelines in using diplomacy for science:

1. Strong, clear science objectives
2. Enthusiastic scientific partners
3. Good, open communication
4. Delivering on promises made (and therefore ensuring that commitments are realistic in the first place)
5. Flexibility

These five factors allow for trust to be established among all partners, showing that scientific collaboration can overcome even the most obstructive political complications. Earth and environmental science is particularly well placed, being largely separate from any political agenda, and thus offers hope for addressing not only volcanic hazards but also other global scientific issues such as earthquakes, flooding, and climate change. SD

Endnotes

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